FOOD HABITS OF CLOUDED SALAMANDERS (*ANEIDES FERREUS*) IN CURRY COUNTY, OREGON (AMPHIBIA: CAUDATA: PLETHODONTIDAE)

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ABSTRACT.—Stomach contents of 650 clouded salamanders (*Aneides ferreus*), collected monthly throughout the year from Curry County, Oregon, were examined. Samples from three age classes were involved: (1) 489 adults, (2) 131 juveniles, and (3) 30 hatchlings. Foods did not vary by sex, but did vary by age and by season. Hatchlings ate small items, particularly mites, springtails, flies, and small beetles. Juveniles fed mainly on flies, isopods (sowbugs), beetles, mites, and centipedes in winter; beetles, ants, and isopods in spring; ants and beetles in summer; and isopods, beetles, and ants in fall. Adults ate isopods and beetles as their major foods in winter, spring, and fall and isopods, ants, beetles, and earwigs in summer. Four species were exceedingly important as foods for these salamanders: an unidentified isopod, the snout beetle (*Trachyphloeus bifoveatus*), the European earwig (*Forficula auricularia*), and an ant (*Lasius alienus*).

The clouded salamander (*Aneides ferreus*) is found from coastal northwestern California northward throughout western Oregon west of the Cascade Range to the Columbia River. Disjunct populations occur on Vancouver Island, British Columbia. In Oregon the clouded salamander is found from sea level to elevations of about 1525 m (Beatty 1979).

Aneides ferreus is associated with two basic types of habitat throughout its range—talus and fallen trees (Beatty 1979). Large fallen trees are the product of old-growth forests (Franklin et al. 1981, Harris et al. 1982). In Oregon the fallen tree habitat used by *A. ferreus* is essentially Douglas-fir (*Pseudotsuga menziesii*) in varying stages of decomposition (Beatty 1979, Maser and Trappe 1984, Phillips et al. 1981).

There have been few food-habit studies of *A. ferreus*. Fitch (1936) examined the stomach of five specimens from the Rogue River Valley in southwestern Oregon. Storm and Aller (1947) examined 63 stomachs from *A. ferreus* found in decaying Douglas-fir logs in western Oregon. Bury and Martin (1973) compared the distribution and foods of four species of plethodontid salamanders, including *A. ferreus*, from the redwood region of northern California; they examined 29 stomachs of this species.

Our study was undertaken to gain a more comprehensive idea of the food habits of *A. ferreus* throughout the year, by size groups, and by sex. All salamanders had been collected and preserved in connection with a previous study (Beatty 1979).

STUDY AREA

The study area, located 9.5 km south of the Pistol River, Curry County, Oregon, is in the Sitka spruce (*Picea sitchensis*) zone within the Klamath Mountains Province (Franklin and Dyrness 1973). The study area was burned in 1937 and 1938 and was salvage logged in the late 1950s and early 1960s. It has since been grazed continuously by domestic sheep (*Ovis aries*) (Fig. 1).

The area is open (low grass-forb vegetation with clumps of swordfern (*Polystichum munitum*) and trailing blackberry (*Rubus ursinus*). The widely scattered trees include Douglas-fir, Sitka spruce, Pacific madrone (*Arbutus menziesii*), California laurel (*Umbellularia californica*), and clumps of red alder (*Alnus rubra*). Several large, charred Douglas-fir snags were still standing when the salamanders were collected (from 1974 through 1977), and the land was strewn with many large, fallen, decomposing, Douglas-fir trees. These trees composed the habitat of *A. ferreus* (Fig. 1).

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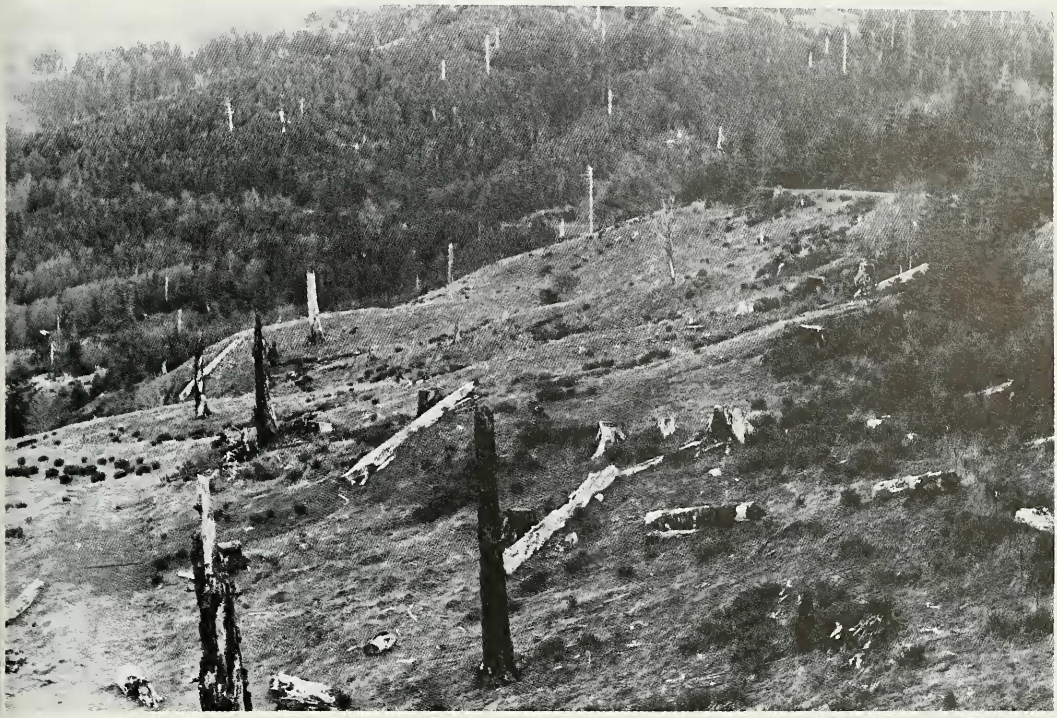

Fig. 1. Study area, 9.5 km south of the Pistol River, Curry County, Oregon. The large, woody materials formed the habitat of the clouded salamander.

MATERIALS AND METHODS

The salamanders were collected by dissecting fallen trees and were placed in refrigerated containers to keep them cool and moist. They were transported to the laboratory within 24 hours (except the May sample), killed in 0.2% chlorobutanol, fixed in alcohol-formalin-acetic acid (AFA), washed in running tap water for 24 hours, and stored in 63% ethanol. Snout-vent length (SVL) was measured from the tip of the snout to the anterior edge of the cloaca.

The stomachs were opened later and the preserved food items were removed. Salamanders from every month of the year, except May, had food in their stomachs; the lack of food in specimens taken in May was probably the result of not preserving them soon enough after capture. Food items were examined in water with the aid of a 10-70 power zoom dissecting microscope. The food was identified as completely as possible, counted, and percent volumes visually calculated for each type of food in each stomach. Data were then summarized as mean percent volume, frequency of occurrence in stomachs, and percent frequency that each item composed of the total number of items. Data were separated by month, year, age class, and sex in the adult salamanders.

RESULTS AND DISCUSSION

Results are given in Tables 1–6. To determine if there were any qualitative differences in feeding behaviors because of age, we separated the data into the following age classes: (1) adults (SVL > 45 mm), (2) juveniles (SVL 22–44 mm), and (3) hatchlings (SVL 14–19 mm).

Adults (SVL 45+ mm)

It appeared that foods of adult *A. ferreus* did not vary greatly by sex. To assess similarities and differences we used four of the larger individual samples: (1) 32 males, 54 females; 24 March 1976; (2) 15 males, 16 females; 11 April 1975; (3) 18 males, 13 females; 13 August 1976; (4) 15 males, 14 females; 30 November 1974.

TABLE 1. Food eaten in winter (December–February) by 55 adult *Aneides ferreus* (snout-vent length 45+ mm) from Curry County, Oregon.

Food item	Percent volume	Percent of individuals	Total percent volume for major group
ISOPODA	44.0	39.4	(44.0)
COLEOPTERA			(22.9)
Curculionidae			(18.9)
Trachyphloeus bifoveatus	16.1	17.1	
Brachyrhinus rugosostriatus	1.8	0.6	
Chactechus setiger	0.7	1.8	
Unidentified	0.3	0.6	
Carabidae			
Amara sp.	0.7	0.6	
Scarabaeidae			
Aphrodius cribratulus	2.6	1.8	
Unidentified adult	0.7	0.6	
DERMAPTERA			(5.9)
Forficula auricularia	10.8	5.9	
DIPTERA			(5.8)
Sciaridae	2.9	8.2	
Mycetophilidae	1.9	1.8	
Phoridae	0.1	0.6	
Unidentified larvae	0.9	1.2	
ARANEIDA			(4.2)
Gnaphosidae	2.1	1.2	
Antrodiaetus pacificus	1.0	0.6	
Ebo sp. probably *pepinensis*	0.2	1.2	
Amaurobiidae	0.9	1.2	
Micryphantidae	0.04	0.6	
CHILOPODA	1.8	0.6	(1.8)
DIPLOPODA	1.8	0.6	(1.8)
HOMOPTERA			(0.7)
Aphididae	0.3	1.2	
Cercopidae	0.2	0.6	
Cicadellidae	0.2	0.6	
HYMENOPTERA			(0.7)
Formicidae			
Aphaenogaster subterraneus	0.6	1.8	
Lasius alienus	0.1	0.6	
Unidentified	0.04	0.6	
NEUROPTERA			(0.7)
Hemerobiidae	0.7	0.6	
HEMIPTERA			(0.3)
Tingidae	0.3	0.6	
ACARINA	0.1	1.8	(0.1)
COLLEMBOLA	0.04	3.5	(0.04)
Vegetation	3.3	—	
Unidentified insect	1.7	2.4	
Shed skin	1.1	—	
	100.0	99.9	

Percentages varied, perhaps because of small sample sizes. The preferred foods were identical in each case—sowbugs (isopods) ranked highest in three of the samples, but ants ranked highest in the 13 August sample. The next most abundant foods were snout beetles (curculionids) in the first two samples, isopods in the third sample, and beetles (coleopterans) in the fourth sample.

The number of sowbugs eaten by female salamanders was greater than the number eaten by males in three of the four samples; for example, females ate 23.8% more sowbugs in November than did the males. Spiders formed 16.1% by volume of the male diet in November but were absent from the female diet. In the August sample, spiders composed 11.5% by volume of the female salamander

TABLE 2. Foods eaten in spring (March–May) by 212 adult *Aneides ferreus* (snout-vent length 45+ mm) from Curry County, Oregon.

Food item	Percent volume	Percent of individuals	Total percent volume for major group
ISOPODA	61.4	41.7	(61.4)
COLEOPTERA			(19.8)
Curculionidae			(14.6)
Trachyphloeus bifoveatus	11.7	10.1	
Chaetechus setiger	2.1	2.0	
Rhyncolus sp.	0.6	0.4	
Brachyrhinus ovatus	0.2	0.1	
Carabidae			(3.0)
Calathus ruficollis	1.5	0.7	
Harpalus sp.	0.5	0.2	
Amara sp.	0.3	0.1	
Brachyrhinus rugosostriatus	0.3	0.2	
Unidentified	0.4	0.4	
Coccinellidae			
Soymnus ardelio	0.5	0.4	
Elateridae	0.2	0.1	
Byrrhidae			
Lioon simplicipes	0.1	0.1	
Tenebrionidae			
Tenebrio sp.	0.1	0.1	
Cucujidae	0.02	0.1	
Staphylinidae			
Tachyporus chrysomelinus	0.01	0.1	
Unidentified Coleoptera	1.0	1.8	
Unidentified larvae	0.3	0.1	
HYMENOPTERA			(5.2)
Formicidae			(5.0)
Lasius alienus	1.7	6.5	
Lasius pallitarsus	1.0	1.2	
Aphaenogaster subterraneus	0.7	3.2	
Tapinoma sessile	0.02	0.1	
Stenamma diecki	0.01	0.1	
Leptothorax sp.	0.01	0.1	
Unidentified	1.4	2.3	
Cynipoidea	0.1	0.2	
Vespidae	0.1	0.1	
DEMAPTERA			(5.0)
Forficula auricularia	5.0	5.5	
ARANEIDA			(3.7)
Linyphiidae	0.4	0.6	
Antrodiaetus pacificus	0.4	0.1	
Lycosidae	0.4	0.2	
Gnaphosidae	0.2	0.1	
Micryphantidae	0.1	0.1	
Mimetus hesperus	0.01	0.1	
Unidentified	2.2	1.5	
DIPTERA			(2.5)
Sciaridae	0.9	4.9	
Mycetophilidae	0.4	0.9	
Chironomidae	0.1	0.7	
Chironomid larvae	0.02	0.1	
Phoridae	0.02	0.1	
Dipterous larvae	0.1	0.2	
Unidentified	1.0	0.9	
ACARINA	0.11	4.7	(0.11)
CHILOPODA	0.6	0.6	(0.6)
LEPIDOPTERA			(0.3)
Larvae	0.2	0.1	
Adults	0.1	0.1	

Table 2 continued.

Food item	Percent volume	Percent of individuals	Total percent volume for major group
HOMOPTERA			(0.2)
Aphididae	0.2	0.2	
Cercopidae	0.04	0.1	
ORTHOPTERA			(0.2)
Gryllidae	0.2	0.1	
DIPLOPODA	0.1	0.2	(0.1)
HEMIPTERA			(0.1)
Tingidae	0.1	0.5	
COLLEMBOLA	0.06	3.3	(0.06)
Unidentified insects	0.4	0.7	
Vegetation	0.1	—	
	99.7	99.0	

TABLE 3. Foods eaten in summer (June–August) by 94 adult *Aneides ferreus* (snout-vent length 45+ mm) from Curry County, Oregon.

Food item	Percent volume	Percent of individuals	Total percent volume for major group
ISOPODA	25.3	8.9	(25.3)
HYMENOPTERA			(23.8)
Formicidae			(23.6)
Lasius alienus	15.2	55.5	
Tapinoma sessile	4.7	11.3	
Lasius pallitarsus	2.1	2.2	
Aphaenogaster subterraneus	1.3	0.5	
Leptothorax nitens	0.1	0.2	
Leptothorax crassipilis	0.1	0.2	
Leptothorax andrei	0.1	0.2	
Unidentified Hymenoptera	0.2	0.2	
COLEOPTERA			(22.4)
Curculionidae			(13.0)
Trachyphloeus bifoveatus	6.4	2.4	
Sitona hispidula	3.1	0.7	
Brachyrhinus rugosostriatus	1.9	0.7	
Rhyncolus sp.	1.2	0.3	
Chaetechus setiger	0.4	0.7	
Carabidae			
Calathus ruficollis	2.8	1.4	
Tenebrionidae			(2.0)
Helops sp.	1.1	0.2	
Phthora americanum	0.9	0.7	
Elateridae			
Ctenicera sp.	1.1	0.2	
Ostomidae			
Ostoma pippingskoldii	1.1	0.2	
Throscidae			
Pactopus hornii	0.6	0.2	
Staphylinidae			(0.5)
Quedius sp.	0.2	0.2	
Stenus sp.	0.1	0.2	
Byrrhidfae			
Lioon simplicipes	0.4	0.2	
Anobiidae			
Coelostethus quadrulus	0.3	0.2	

Table 3 continued.

Food item	Percent volume	Percent of individuals	Total percent volume for major group
Aleocharinae	0.1	0.2	
Atheta sp.	0.04	0.2	
Unidentified	0.02	0.2	
Cucujidae			
Pediacus depressus	0.1	0.2	
Scydmaenidae			
Lophioderus similis	0.1	0.2	
Unidentified	0.4	0.3	
DERMAPTERA			(11.9)
Forficula auricularia	11.9	4.1	
HOMOPTERA			(3.0)
Cercopidae	1.6	0.7	
Aphididae	0.02	0.2	
Unidentified	1.4	0.3	
LEPIDOPTERA			(2.9)
Larvae	2.3	1.0	
Adults	0.6	0.2	
ARANEIDA			(1.9)
Microphantidae	1.1	0.2	
Linyphiidae	0.6	0.3	
Ebo probably *pepinensis*	0.2	0.2	
CHILOPODA	1.8	0.5	(1.8)
HEMIPTERA			(1.6)
Lygaeidae	0.6	0.5	
Unidentified	1.0	0.3	
NEUROPTERA			(1.6)
Hemerobiidae	1.6	0.7	
DIPTERA			(0.7)
Sciaridae	0.02	0.2	
Unidentified larvae	0.6	0.5	
Unidentified	0.05	0.2	
PHALANGIDA	0.7	0.5	(0.7)
ORTHOPTERA			(0.6)
Gryllidae			
Gryllus sp.	0.6	0.2	
ISOPTERA			(0.4)
Holotermitidae			
Zootermopsis angusticollis	0.4	0.3	
NEMERTINEA	0.2	0.2	(0.2)
COLLEMBOLA	0.1	0.2	(0.1)
Vegetation	1.5	—	
	100.4	100.5	

diet but were absent from the stomachs of males. Thus, little or no preference for spiders was shown by either sex.

When the same four samples were combined, females were found to eat more sowbugs, curculionid beetles, and spiders than did males, but males did not eat appreciably more of any of the foods than did females. These data suggest that males use a greater diversity of foods. If this is true, then the total volume of these main foods should be greater in females than in males, but such a major difference (67.5% in males versus 81.5% in females) was only found in the August sample. Neither does such a trend show up when the number of food categories listed for each sex is examined. For example, 11 categories of foods were eaten by males and females in April and 15 by each sex in November. In August 22 categories were eaten by males and 12 by females; in March 24 categories were eaten by females and 14 by males. We combined the data for the sexes for seasonal comparisons because we detected no major differences in kinds of foods eaten by males versus females.

TABLE 4. Foods eaten in fall (September–November) by 125 adult *Aneides ferreus* (snout-vent length 45+ mm) from Curry County, Oregon.

Food item	Percent volume	Percent of individuals	Total percent volume for major group
ISOPODA	46.5	38.3	(46.5)
COLEOPTERA			(24.1)
Curculionidae			(16.0)
Trachyphloeus bifoveatus	13.8	12.0	
Chaetechus setiger	1.6	3.8	
Sitona hispidulus	0.2	0.1	
Unidentified	0.4	0.6	
Carabidae			(5.1)
Calathus ruficollis	4.5	1.8	
Unidentified	0.6	0.6	
Tenebrionidae			(0.9)
Phthora americanum	0.5	1.0	
Unidentified	0.4	0.1	
Scarabaeidae			(0.7)
Aphrodius sp.	0.7	0.6	
Staphylinidae			(0.3)
Atheta sp.	0.3	0.3	
Pselaphidae			(0.04)
Batrisodes sp.	0.04	0.1	
Unidentified	1.0	0.9	
Unidentified larvae	0.1	0.1	
HYMENOPTERA			(6.1)
Formicidae			(5.5)
Lasius alienus	2.1	9.0	
Aphaeonogaster subterranea	1.6	1.8	
Ant species #9	0.6	3.1	
Tapinoma sessile	0.5	1.6	
Camponotus vicinus	0.2	0.1	
Stenamma diecki	0.2	0.6	
Stenamma sp.	0.1	0.4	
Ant species #10	0.02	0.1	
Unidentified	0.2	0.7	
Vespidae	0.3	0.1	
Braconidae	0.1	0.1	
Unidentified	0.2	0.3	
DERMAPTERA			(4.6)
Forficula auricularia	4.6	1.2	
ARANEIDA			(4.3)
Clubionidae			
Trachelus californicus	0.4	0.3	
Gnaphosidae	0.4	0.1	
Linyphiidae	0.3	1.2	
Lycosidae	0.2	0.3	
Ebo probably *pepinensis*	0.1	0.1	
Micryphantidae	0.1	0.3	
Unidentified	2.8	1.0	
HEMIPTERA			(3.7)
Tingidae	1.4	1.5	
Lygaeidae	1.2	0.6	
Reduviidae	0.6	0.1	
Nabidae	0.5	0.3	
Unidentified	0.04	0.1	
LEPIDOPTERA			(1.6)
Adult	1.2	0.6	
Larvae	0.4	0.6	
HOMOPTERA			(1.5)
Cercopidae	1.1	1.0	
Aphididae	0.3	0.4	
Cicadellidae	0.1	0.1	

Table 4 continued.

Food item	Percent volume	Percent of individuals	Total percent volume for major group
DIPTERA			(1.4)
Tipulidae	0.9	0.9	
Sciaridae	0.04	0.1	
Mycetophilidae	0.04	0.1	
Dipterous larvae	0.1	0.3	
Unidentified	0.3	0.3	
ISOPTERA			(0.8)
Holotermitidae			
Zootermopsis augusticollis	0.8	3.5	
ORTHOPTERA			(0.4)
Gryllidae			
Gryllus sp.	0.4	0.1	
PHALANGIDA	0.4	0.6	(0.4)
ACARINA	0.3	2.4	(0.3)
NEUROPTERA			(0.3)
Hemerobiidae	0.2	0.3	
Larvae	0.1	0.1	
COLLEMBOLA	0.2	1.3	(0.2)
DIPLOPODA	0.1	0.1	(0.1)
Vegetation and debris	2.0	—	(2.0)
Unidentified insect	1.6	0.9	(1.6)
Unidentified insect larvae	0.04	0.1	(0.04)
	100.0	99.1	

WINTER.—We examined the stomachs of 55 adult salamanders taken during winter—December through February (Table 1). The major foods (by volume) were: (1) sowbugs, 44%; (2) beetles, 22.9% (primarily Curculionidae, 18.9%); (3) earwigs, 5.9%; (4) flies, 5.8%; and (5) spiders, 4.2%. Ants composed 0.7% of the total volume in the sample.

Three species were disproportionately important: (1) sowbugs 44.0%, (2) snout beetles (*Trachyphloeus bifoveolatus*) 16.1%, and (3) European earwigs (*Forficula auricularia*) 5.9%. The three species totaled 66.0% by volume of the total prey eaten. The same items occurred in 70.9%, 32.7%, and 16.4%, respectively, of the stomachs in the sample. They also composed 39.4%, 17.1%, and 5.9%, or a total of 62.4% of the total items eaten by the 55 salamanders. Although 33 kinds of food were eaten, the winter diet of *A. ferreus* in this locality was rather simple.

SPRING.—Stomachs of 212 salamanders were examined for spring diet—March through May (Table 2). Sowbugs were the major food, 61.4% by volume. Beetles, primarily curculionids, were second, 14.6% by volume. These items were followed by ants and earwigs, each composing 5.0%, and spiders, which accounted for 3.7% of the volume.

The three species (sowbug, snout beetle, and European earwig) that formed 66% of the winter diet, by volume, formed 78.1% of the spring diet—61.4%, 11.7%, and 5.0%, respectively, by volume. Sowbugs occurred in 80.7%, snout beetles in 28.3%, and earwigs in 9.9% of the stomachs, whereas the three composed 41.7%, 10.1%, and 5.5%, respectively, for a total of 57.3% of the items eaten.

Foods eaten in spring were relatively similar to those eaten in winter. The major difference was that flies decreased in use and ants increased.

SUMMER.—We studied the contents of 94 stomachs from salamanders collected from June through August (Table 3). Major differences in food habits among winter, spring, and summer were that in summer sowbugs and the snout beetles (*Trachyphloeus bifoveatus*) were much less important, even though beetles, as a whole, were about the same. Ants became an important food in summer and formed almost 25% of the diet. One ant (*Lasius alienus*), in fact, made up 55.5% of

TABLE 5. Foods of 131 juvenile *Aneides ferreus* (snout-vent length 20–45 mm from Curry County, Oregon. Presented as percent volume and percent of prey individuals.

Food item	Winter		Spring		Summer		Fall	
	Volume %	Individuals %	Volume %	Individuals %	Volume %	Individuals %	Volume %	Individuals %
ISOPODA	15.2	9.7	14.5	4.3	6.7	1.8	39.0	13.3
ACARINA	11.4	25.0	8.7	27.8	3.5	22.4	1.3	8.0
CHILOPODA	11.3	5.6						
COLLEMBOLA	5.5	23.6	4.4	22.2			3.8	44.4
COLEOPTERA								
Curculionidae								
Trachyphloeus bifoveatus	8.0	2.8	5.8	1.3	4.8	1.8	13.6	6.6
Chaetechus setiger			20.1	7.4				
Sitona hispidulus	0.4	1.4						
Rhyncolus sp.			0.5	0.4	1.3	0.6		
Carabidae								
Calathus ruficollis	1.0	1.4			1.2	0.6	1.9	0.3
Unidentified			2.4	0.4				
Coccinellidae								
Scymnus ardelio	4.0	1.4						
Staphylinidae								
Sitnao sp.			1.1	0.4				
Unidentified			2.3	1.3			0.5	0.3
Tenebrionidae								
Phthora americana							0.6	0.3
Byrrhidae								
Listemus formosus			1.1	0.4				
Pselaphidae			0.8	0.4	1.0	0.6		
Cucujidae					3.3	0.6		
Unidentified					3.3	0.6	1.4	1.0
Larvae					2.3	0.6		
HYMENOPTERA								
Formicidae								
Lasius alienus			1.3	1.3	24.3	38.2	9.2	5.6
Lasius pallitarsus			3.6	11.3	2.3	1.2		
Aphaenogaster subterranea			0.5	0.4	8.0	12.7		
Tapinoma sessile			0.3	0.4	9.5	7.3		
Stenamma diecki	4.4	2.8	0.5	0.4				
Unidentified	1.2	2.8	15.4	8.3	6.3	2.4	7.7	5.6
Unidentified							0.3	0.3
DIPTERA								
Sciaridae	4.0	4.2			2.5	1.2	0.1	0.3
Tipulidae	3.6	1.4						
Culicidae	0.4	1.4						
Phoridae			0.9	0.4				
Syrphidae					1.7	0.6		
Larvae	7.8	4.2					4.2	4.5
Unidentified	3.6	2.8	0.4	0.9				
LEPIDOPTERA								
Adult					1.8	0.6	1.2	0.3
Larvae							2.6	0.3
DERMAPTERA								
Forficula auricularia			1.4	0.9	0.7	0.6		
HOMOPTERA								
Cicadellidae			0.2	0.4	2.0	1.8	1.8	0.3
Cercopidae			0.9	2.2			0.1	0.3
Aphididae			0.9	2.2			0.1	0.3
Unidentified no results								
HEMIPTERA								
Lygaeidae	4.0	1.4			0.7	0.6		
Tingidae	3.8	2.8	1.6	0.4			0.8	1.4
Unidentified	0.8	1.4					0.5	0.3

Table 5 continued.

Food item	Winter		Spring		Summer		Fall	
	Volume %	Individuals %	Volume %	Individuals %	Volume %	Individuals %	Volume %	Individuals %
NEUROPTERA								
Hemerobiidae					3.3	0.6		
ARANEIDA								
Linyphiidae	4.0	1.4						
Ebo pepinensis							0.6	0.7
Xysticus sp.							0.6	1.0
Unidentified			3.8	1.7	0.3	0.6	1.4	1.7
PHALANGIDA							1.3	0.3
DIPLOPODA							0.5	0.7
ISOPTERA								
Holotermitidae								
Zootermopsis augusticollis			5.3	2.6				
Unidentified insect	5.6	2.8	1.6	1.3	2.7	0.6	0.5	0.7
Insect larvae			0.5	0.4			3.2	0.7
Vegetation and debris					4.3	—		
Shed skin							0.6	—
	100.0	100.3	99.9	99.6	99.8	99.8	100.1	99.5

all items eaten and 15.0% of the volume. Ants, as a whole, composed 70.2% of all organisms in the sample.

The three species that had been so important in winter and spring composed 43.6% of the summer diet: sowbugs, 25.3%; snout beetles, 6.4%; and European earwigs, 11.9%. There was nearly as great a diversity of foods represented in summer (52 categories) from a sample of 94 stomachs as in spring (55 categories) with a sample of 212 stomachs.

FALL.—We examined 125 salamander stomachs collected during fall—September through November (Table 4). Data for fall resembled those for spring. Major fall foods were sowbugs (46.5% by volume), beetles (24.1%, including 16.0% curculionids), ants (5.5%), European earwigs (4.6%), and spiders (4.3%). *Lasius alienus* was again the most important ant (61 individuals) and formed 2.1% of the volume and 9.0% of the total items in stomachs.

The three species that have been the most important foods, the sowbug, snout beetle, and European earwig, formed, respectively, 46.5%, 13.8%, and 4.6% of the volume, or 64.9% total volume; they also composed, respectively, 38.3%, 12.0%, and 1.2%, or a total of 51.5% of the organisms in the sample.

ANNUAL.—The sowbug was the major food item of *A. ferreus* throughout the year, but it had its lowest relative use in summer. Beetles, collectively, and curculionid beetles in particular were clearly second by volume except in summer when ants were eaten in slightly greater amounts. European earwigs and/or ants were generally in third position by total volume. The earwigs were third in winter. Earwigs and ants were used about equally by volume in fall. Ants were second by volume in summer, followed by beetles, then earwigs, even though earwigs contributed their greatest volume (11.9%) during this time.

In terms of percent of prey individuals eaten, sowbugs, followed by beetles (mainly curculionids), were highest in winter, spring, and fall. The third and fourth most used food items were flies (11.8%) and earwigs (5.9%) in winter, ants (13.7%) and flies (7.9%) in spring, and ants (17.6%) and spiders (3.4%) in fall. Ants came first in summer; 70.0% of the organisms eaten were ants, followed by beetles (9.4%), sowbugs (8.9%), and earwigs (4.1%).

Juveniles (SVL 20–45 mm)

WINTER.—The major foods of juveniles in winter (Table 5) were, in order of decreasing volume, flies (19.4%), sowbugs (15.2%), beetles (13.4%), mites (11.4%), centipedes (11.3%), hemipterans (8.6%), ants (5.6%), and

TABLE 6. Foods of 30 hatchling *Aneides ferreus* (snout-vent length 14–19 mm) from Curry County, Oregon.

	Fall (n = 17)			Winter (n = 13)		
	Volume %	Frequency %	Individuals %	Volume %	Frequency %	Individuals %
ACARINA	30.3	76.5	28.0	10.4	30.8	15.0
COLLEMBOLA	27.9	70.6	62.3	16.5	38.4	56.3
COLEOPTERA						
Trachyphloeus bifoveatus				5.8	7.7	1.3
Unidentified	14.7	35.3	3.4	7.7	7.7	3.8
HYMENOPTERA						
Formicidae	5.3	11.8	1.0	4.6	7.7	3.8
HOMOPTERA						
Cicadellidae				7.7	7.7	1.3
HEMIPTERA						
Tingidae	3.8	11.8	1.0			
DIPTERA						
Sciaridae				15.0	15.4	10.0
Chironomidae				7.7	7.7	1.3
Culicidae				3.8	15.4	3.8
Mycetophilidae				1.2	7.7	1.3
Larvae	4.4	17.6	2.9			
DIPLOPODA	2.9	5.9	0.5			
ARANEIDA	0.9	5.9	0.5	7.7	7.7	1.3
Insect larvae	5.9	5.9	0.5			
Unidentified insect				6.5	7.7	1.3
Unidentified material	3.8	17.6	—			
Vegetation				5.8	7.7	—
	99.9		100.1	100.4		100.5

springtails (5.5%). Thus, no foods were dominant. Rather, the important foods of hatchlings—flies, mites, and springtails—were still important but in lesser amounts, whereas some of the important foods of adults—sowbugs and snout beetles—were becoming important but much less so than in adults. This sample suggests a transition from foods of hatchlings to those of adults. The transition is apparently based on size of prey, from small to large, as a salamander grows.

SPRING.—By spring the juveniles could contend with larger prey items as follows, in decreasing volume: beetles (34.1%)—again primarily snout beetles; ants (21.6%); sowbugs (14.5%); mites (8.7%); termites (5.3%); and springtails (4.4%). There was considerable change from the foods eaten in winter. Flies, centipedes, and bugs decreased, and beetles and ants increased. The decrease in flies in the diet in spring, summer, and fall may be explained by availability. Flies are present and may be relatively inactive in fallen trees in winter, but in summer they either may not be present in large numbers or may be more active and caught less often. Ants may also be more abundant in spring, summer, and fall. Beetles are eaten more often, probably because the more mature salamanders have an easier time capturing them. We do not have a good explanation for the decrease in centipedes and bugs. These organisms only compose a major food source in winter, and even then only four centipedes and four bugs were involved, but each accounted for a large part of the respective stomach contents.

SUMMER.—The most important summer food was ants (50.4% by volume, 61.8% of the total prey). Ants were followed by beetles (17.2%), flies (4.2%), and mites (3.5%). No springtails occurred, and sowbugs—a major food in all other seasons—formed only 1.8% of the volume.

FALL.—The major items by volume were sowbugs (39.0%), beetles (18.0%), and ants (16.9%).

Many or most of the salamanders classified as juveniles have progressed past the size when the main foods were springtails, mites, and flies. This progress is best illustrated in a single collection of 38 subadult salamanders taken with full stomachs during 29–30 November 1974. Subadults separated nicely

into two size classes: (1) 17 individuals with a snout-vent length of 14–18 mm, $\bar{x} = 16.9$, and (2) 21 individuals with a snout-vent length of 24–36 mm, $\bar{x} = 29.3$. Stomachs of hatchlings contained mites (30.3%) and springtails (27.9%); these two foods totaled 58.2% of the diet. Stomachs of juveniles contained only 7.0% springtails and 2.5% mites for a total of 9.5% for these two items.

Hatchlings (SVL 14–19 mm)

Among the smallest salamanders were six nestlings attended by both an adult male and female. The nest was found 13 September 1976. Five of the nestlings had stomachs that contained 100% yellowish material, thought to be yolk. The sixth had a stomach that contained three mites (5% by volume), an ant (*Tapinoma sessile*) (15%), a mycetophilid fly (30%), and a linyphyid spider (50%). Some feeding may therefore occur while the young are still in the nest.

With the exception of the above young and one collected in April, hatchlings (<20 mm SVL) were found from November through February. Of these, 17 were taken in fall and 13 in winter (Table 6). As expected, food items were small. Major foods in the fall sample, in order of decreasing volume, were mites, springtails, and very small beetles. These three groups composed 72.9% of the total volume. The mites and springtails occurred in about 70% to 75% of the stomachs, and the three together accounted for 93.7% of the prey items in the sample. No flies were found.

Small food items also dominated the winter sample. Springtails formed the most abundant prey items (56.3% of the total), but flies—primarily dark-winged fungus gnats, Sciaridae—made up the greatest collective volume (27.7%). In order of importance, by decreasing volume, were flies, springtails, very small beetles, mites, and spiders.

Conclusions

A newly hatched clouded salamander eats small food items (mites and springtails). As an individual matures, the size of prey increases to larger items, such as beetles and earwigs. All the prey listed in this paper can be found in and around large, fallen, decomposing Douglas-fir trees. Large, rotting Douglas-fir trees concentrate the salamanders' food; for example, some beetles and flies, eaten by the salamanders, depend on these trees for part or all of their life cycles (Deyrup 1975, 1976). Further, large, decomposing Douglas-fir trees remain moist inside during summer drought (Maser and Trappe 1984) and thereby maintain quality habitat not only for the clouded salamander but also for its food supply.

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Literature Cited

BEATTY, J. J. 1979. Morphological variation in the clouded salamander, *Aneides ferreus* (Cope) (Amphibia: Caudata: Plethodontidae). Unpublished dissertation, Oregon State University, Corvallis. 94 pp.

BURY, R. B., AND M. MARTIN. 1973. Comparative studies on the distribution and foods of plethodontid salamanders in the redwood region of northern California. J. Herpetol. 7: 331–335.

DEYRUP, M. A. 1975. The insect community of dead and dying Douglas-fir. 1: The Hymenoptera. Coniferous For. Biome, Ecosyst. Anal. Stud. Bull. 6. 104 pp.

———. 1976. The insect community of dead and dying Douglas-fir: Diptera, Coleoptera, and Neuroptera. Unpublished dissertation, University of Washington, Seattle. 504 pp.

FITCH, H. S. 1936. Amphibians and reptiles of the Rogue River Basin, Oregon. Amer. Midl. Nat. 17(3): 634–652.

FRANKLIN, J. F., AND C. T. DYRNESS. 1973. Natural vegetation of Oregon and Washington. USDA For. Serv., Pacific Northwest For. and Range Exp. Stn., Portland, Oregon, Gen. Tech. Rep., PNW-8. 417 pp.

FRANKLIN, J. F., K. CROMACK, JR., W. DENISON, A. MCKEE, C. MASER, J. SEDELL, F. SWANSON, AND G. JUDAY. 1981. Ecological characteristics of old-growth Douglas-fir forests. USDA For. Serv., Pacific Northwest For. and Range Exp. Stn., Portland, Oregon. Gen. Tech. Rep., PNW-118. 48 pp.

HARRIS, L. D., C. MASER, AND A. MCKEE. 1982. Patterns of old growth harvest and implications for Cascades wildlife. N. Amer. Wild. and Nat. Resour. Conf. 47: 374–392.

MASER, C., AND J. M. TRAPPE. 1984. The seen and unseen world of the fallen tree. USDA For. Serv., Pacific Northwest For. and Range Exp. Stn., Portland, Oregon. Gen. Tech. Rep., PNW-133. 56 p.

PHILLIPS, C., H. CHROSTOWSKI, A. MCMILLAN, M. WALTER, R. WILSON, AND M. ELTZROTH. 1981. Wildlife habitats and species management relationships program, Oregon Coast Range. Vol. II: Amphibians and reptiles. USDA For. Serv., Pacific Northwest Region, Corvallis, Oregon, Siuslaw Nat. For., 57 pp.

STORM, R. M., AND A. R. ALLER. 1947. Food habits of *Aneides ferreus*. Herpetol. 4(2): 59–60.